Redundancy Protocol
User's Manual

Second Edition, June 2014

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Redundancy Protocol User's Manual

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1

Introduction to Redundancy Protocol

Setting up Redundancy Protocol on your network helps protect critical links against failure, protects against network loops, and keeps network downtime at a minimum.

Redundancy Protocol allows you to set up *redundant loops* in the network to provide a backup data transmission route in the event that a cable is inadvertently disconnected or damaged. This is a particularly important feature for industrial applications, since it could take several minutes to locate the disconnected or severed cable. For example, if the Moxa switch is used as a key communications component of a production line, several minutes of downtime could cause a big loss in production and revenue. The Moxa switch supports three different protocols to support this Redundancy Protocol function:

- **Turbo Ring** and **Turbo Ring V2**
- **Turbo Chain**
- **Rapid Spanning Tree** and **Spanning Tree Protocols** (IEEE 802.1W/802.1D-2004)

When configuring a redundant ring, all switches on the same ring must be configured to use the same redundancy protocol. You cannot mix the Turbo Ring, Turbo Ring V2, and STP/RSTP protocols on the same ring. The following table lists the key differences between the features of each protocol. Use this information to evaluate the benefits of each, and then determine which features are most suitable for your network.

	Turbo Ring	Turbo Ring V2	Turbo Chain	STP	RSTP
Topology	Ring	Ring	Chain	Ring, Mesh	Ring, Mesh
Recovery Time	< 300 ms	< 20 ms	< 20 ms	Up to 30 sec.	Up to 5 sec

NOTE Most of Moxa's managed switches now support three proprietary Turbo Ring protocols:

1. **Turbo Ring** refers to the original version of Moxa's proprietary redundant ring protocol, which has a recovery time of under 300 ms.
2. **Turbo Ring V2** refers to the new generation Turbo Ring, which has a recovery time of under 20 ms.
3. **Turbo Chain** is a new Moxa proprietary protocol with unlimited flexibility that allows you to construct any type of redundant network topology. The recovery time is under 20 ms.

In this manual, we use the terminology **Turbo Ring** and **Turbo Ring V2** to differentiate between rings configured for one or the other of these protocols.

Gigabit Ethernet Redundant Ring Capability (< 50 ms)

Ethernet has become the default data communications medium for industrial automation applications. In fact, Ethernet is often used to integrate video, voice, and high-rate industrial application data transfers into one network. Moxa switches come equipped with a redundancy Gigabit Ethernet protocol called Gigabit Turbo Ring. With Gigabit Turbo Ring, if any segment of the network gets disconnected, your automation system will be back to normal in less than 300 ms (Turbo Ring) or 50 ms (Turbo Ring V2).

NOTE Port trunking and Turbo Ring can be enabled simultaneously to form a backbone. Doing so will increase the bandwidth of the backbone, and also provide redundancy. For example, suppose that two physical ports, 1 and 2, are trunked to form trunk group Trk1, and then Trk1 is set as one Turbo Ring path. If port 1 gets disconnected, the remaining trunked port, port 2, will share the traffic. If ports 1 and 2 are both disconnected, then Turbo Ring will create a backup path within 300 ms.

2

Turbo Ring

The following topics are covered in this chapter:

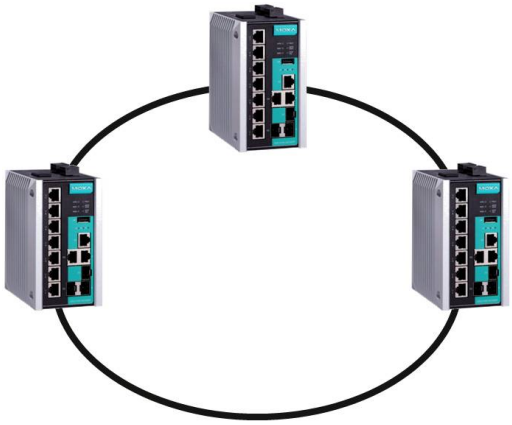
- **The Turbo Ring Concept**
- **Setting up "Turbo Ring" or "Turbo Ring V2"**
  - Determining the Redundant Path of a "Turbo Ring" Ring
  - Determining the Redundant Path of a "Turbo Ring V2" Ring
  - Ring Coupling Configuration
  - Dual-Ring Configuration (applies only to "Turbo Ring V2")
  - Dual-Homing Configuration (applies only to "Turbo Ring V2")
- **Configuring "Turbo Ring" and "Turbo Ring V2"**
  - Configuring "Turbo Ring"

The Turbo Ring Concept

Moxa developed the proprietary Turbo Ring protocol to optimize redundancy and achieve a faster recovery time on the network.

The Turbo Ring and Turbo Ring V2 protocols identify one switch as the ***master*** of the network, and then automatically block packets from traveling through any of the network's redundant loops. In the event that one branch of the ring gets disconnected from the rest of the network, the protocol automatically readjusts the ring so that the part of the network that was disconnected can reestablish contact with the rest of the network.

Setting up "Turbo Ring" or "Turbo Ring V2"



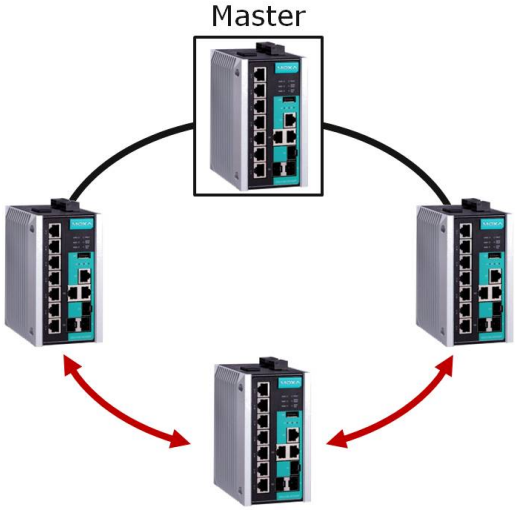
1. Select any two ports as redundant ports.
2. Connect the redundant ports to form the Turbo Ring.

The user does not need to configure any of the switches as the master to use Turbo Ring or Turbo Ring V2. If none of the switches in the ring is configured as the master, then the protocol will automatically assign master status to one of the switches. In fact, the master is only used to identify which segment in the redundant ring acts as the backup path. In the following subsections, we explain how the redundant path is selected for rings configured for Turbo Ring, and Turbo Ring V2.

Determining the Redundant Path of a "Turbo Ring" Ring

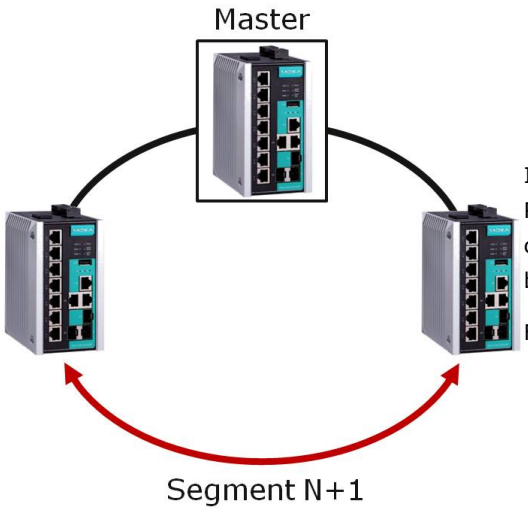
In this case, the redundant segment (i.e., the segment that will be blocked during normal operation) is determined by the number of switches in the ring, and where the ring master is located.

When the Number of Switches in the Turbo Ring is Even



If there are 2N switches (an even number) in the "Turbo Ring" ring, then the backup segment is one of the two segments connected to the (N+1)st switch (i.e., the switch directly opposite the master).

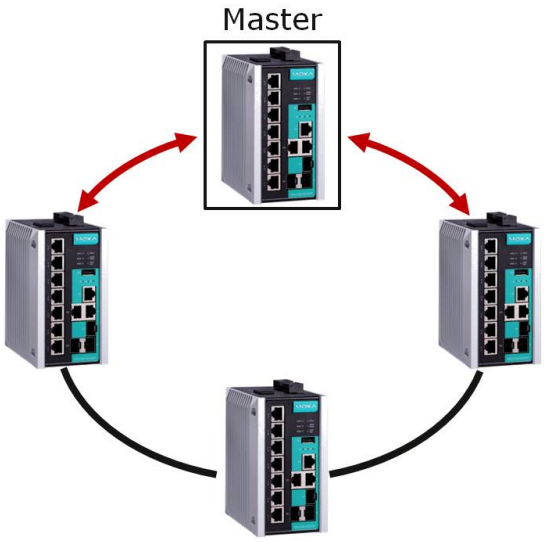
When the Number of Switches in the Turbo Ring is Odd



If there are 2N+1 switches (an odd number) in the "Turbo Ring" ring, with switches and segments labeled counterclockwise, then segment N+1 will serve as the backup path.

For the example shown here, N=1, so that N+1=2.

Determining the Redundant Path of a "Turbo Ring V2" Ring



For a "Turbo Ring V2" ring, the backup segment is the segment connected to the 2nd redundant port on the master.

See Configuring "Turbo Ring V2" in the Configuring "Turbo Ring" and "Turbo Ring V2" section below.

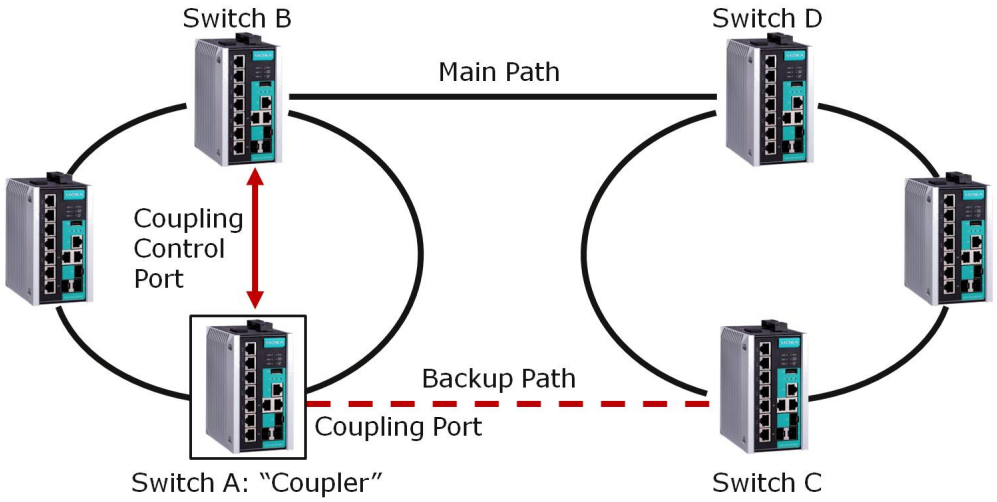
Ring Coupling Configuration

For some systems, it may not be convenient to connect all devices in the system to create one BIG redundant ring, since some devices could be located in a remote area. For these systems, **Ring Coupling** can be used to separate the devices into different smaller redundant rings, but in such a way that they can still communicate with each other.

ATTENTION

In a VLAN environment, the user must set **Redundant Port**, **Coupling Port**, and **Coupling Control Port** to join all VLANs, since these ports act as the *backbone* to transmit all packets of different VLANs to different switches.

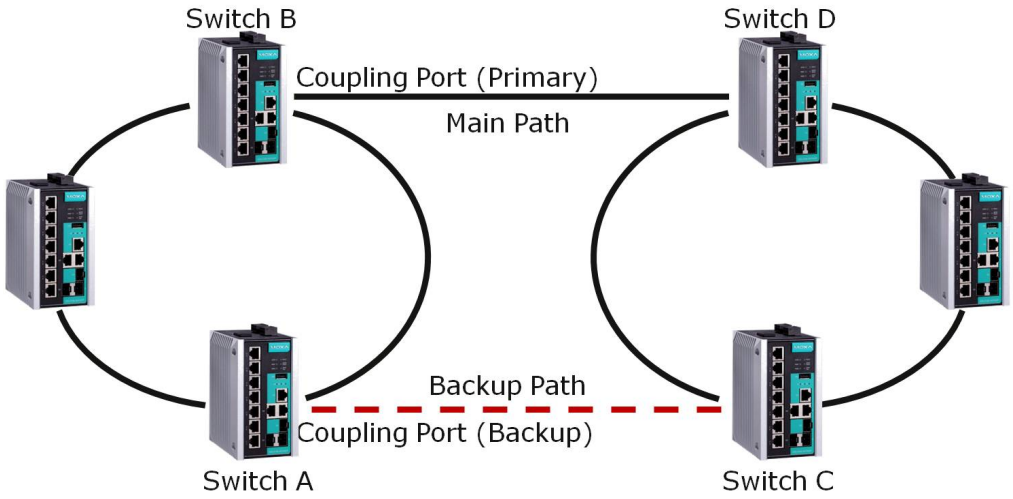
Ring Coupling for a "Turbo Ring" Ring



To configure the Ring Coupling function for a **"**Turbo Ring**"** ring, select two switches (e.g., Switch A and B in the above figure) in the ring, and another two switches in the adjacent ring (e.g., Switch C and D). Decide which two ports in each switch are appropriate to be used as coupling ports, and then link them together. Next, assign one switch (e.g., Switch A) to be the **coupler** and connect the coupler's coupling control port with Switch B (for this example).

The coupler switch (i.e., Switch A) will monitor Switch B through the coupling control port to determine whether or not the coupling port's backup path should be recovered.

Ring Coupling for a "Turbo Ring V2" Ring



Note that the ring coupling settings for a "Turbo Ring V2" ring are different from a "Turbo Ring" ring. For Turbo Ring V2, Ring Coupling is enabled by configuring the **Coupling Port (Primary)** on Switch B, and the **Coupling Port (Backup)** on Switch A only. You do not need to set up a coupling control port, so that a "Turbo Ring V2" ring does not use a coupling control line.

The **Coupling Port (Backup)** on Switch A is used for the backup path, and connects directly to an extra network port on Switch C. The **Coupling Port (Primary)** on Switch B monitors the status of the main path, and connects directly to an extra network port on Switch D. With ring coupling established, Switch A can activate the backup path as soon as it detects a problem with the main path.

ATTENTION

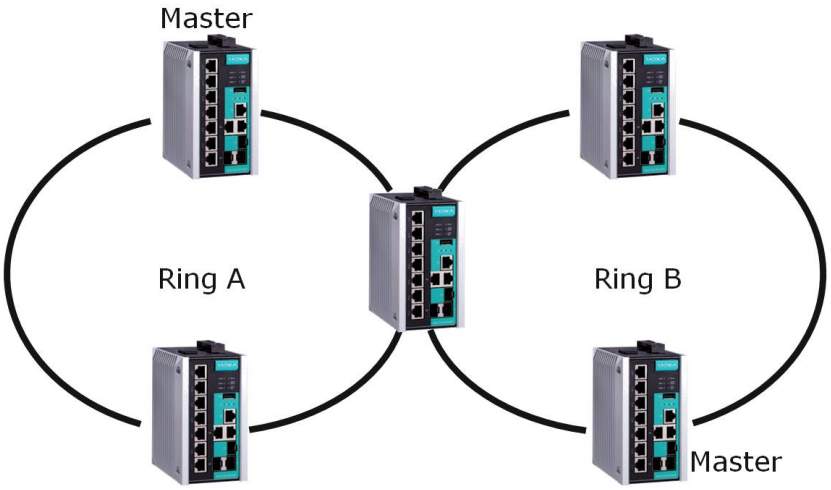
Ring Coupling only needs to be enabled on one of the switches serving as the Ring Coupler. The Coupler must designate different ports as the two Turbo Ring ports and the coupling port.

NOTE You do not need to use the same switch for both Ring Coupling and Ring Master.

Dual-Ring Configuration (applies only to "Turbo Ring V2")

The **dual-ring** option provides another ring coupling configuration, in which two adjacent rings share one switch. This type of configuration is ideal for applications that have inherent cabling difficulties.

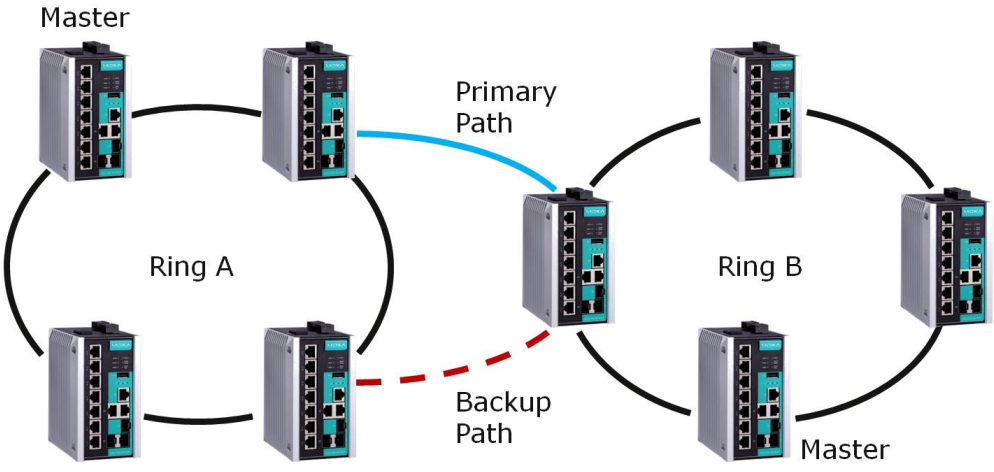
Dual-Ring for a "Turbo Ring V2" Ring



Dual-Homing Configuration (applies only to "Turbo Ring V2")

The **dual-homing** option uses a single Ethernet switch to connect two networks. The primary path is the operating connection, and the backup path is a back-up connection that is activated in the event that the primary path connection fails.

Dual-Homing for a "Turbo Ring V2" Ring



Configuring "Turbo Ring" and "Turbo Ring V2"

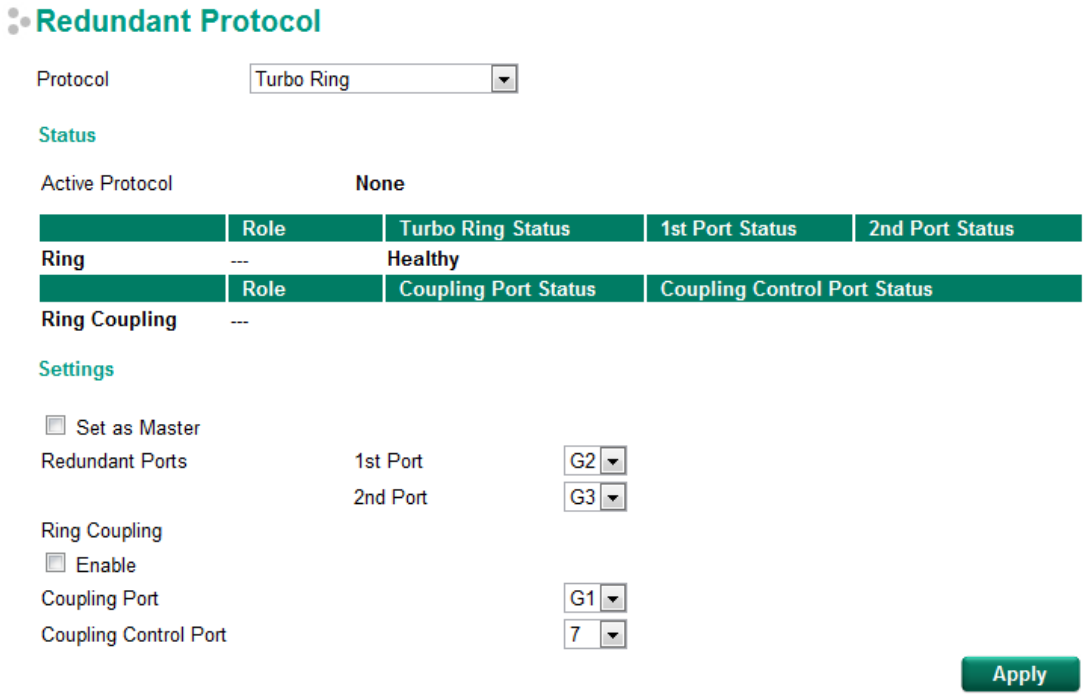
Use the scrollbar at the top of the Redundancy Protocol page to select **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, or **MSTP**. Note that the configuration pages for these five protocols are different.

Protocol

Setting	Description	Factory Default
Turbo Ring	Select this item to change to the Turbo Ring configuration page.	None
Turbo Ring V2	Select this item to change to the Turbo Ring V2 configuration page.	
Turbo Chain	Select this item to change to the Turbo Chain configuration page.	
RSTP (IEEE 802.1D-2004)	Select this item to change to the RSTP configuration page.	
MSTP (IEEE 802.1s)	Select this item to change to the MSTP configuration page.	

Configuring "Turbo Ring"

The following figure indicates which Turbo Ring parameters can be configured. A more detailed explanation of each parameter follows.



Explanation of "Status" Items

Active Protocol

Shows which redundancy protocol is in use: **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, **MSTP** or **None**.

Ring: Role

Indicates whether or not this switch is the **Master** or **Slave** of the Turbo Ring.

NOTE The user does not need to set the master to use Turbo Ring. If master is not set, the Turbo Ring protocol will assign master status to one of the switches in the ring. The master is only used to determine which segment serves as the backup path.

Ring: Turbo Ring Status

Shows **Healthy** if the ring is operating normally, and shows **Break** if the ring's backup link is active.

Ring: 1st Port Status / Ring: 2nd Port Status

The "Ports Status" indicators show ***Forwarding*** for normal transmission, ***Blocking*** if this port is connected to a backup path and the path is blocked, and ***Link down*** if there is no connection.

Ring Coupling: Role

Indicates whether or not this switch is assigned as coupler.

Ring Coupling: Coupling Port Status

Ring Coupling: Coupling Control Port Status

The "Ports Status" indicators show ***Forwarding*** for normal transmission, ***Blocking*** if this port is connected to a backup path and the path is blocked, and ***Link down*** if there is no connection.

Explanation of "Settings" Items

Set as Master

Setting	Description	Factory Default
Enabled	Select this switch as Master	Not checked
Disabled	Do not select this switch as Master	

Redundant Ports

Setting	Description	Factory Default
1st Port	Select any port of the switch to be one of the redundant ports.	Port G2
2nd Port	Select any port of the switch to be one of the redundant ports.	Port G3

Ring Coupling: Enable

Setting	Description	Factory Default
Enable	Select this switch as Coupler	Not checked
Disable	Do not select this switch as Coupler	

Ring Coupling: Coupling Port

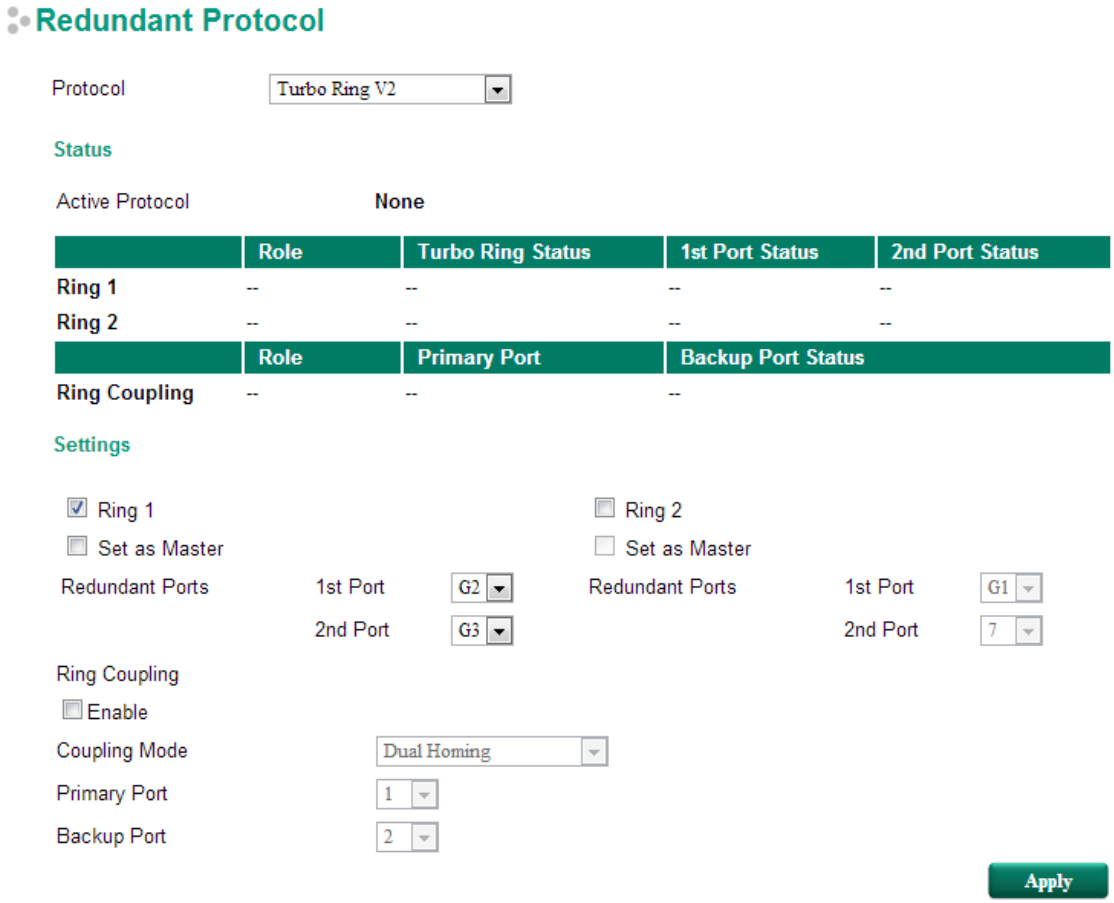
Setting	Description	Factory Default
Coupling Port	Select any port of this switch to be the coupling port	Port G1

Ring Coupling: Coupling Control Port

Setting	Description	Factory Default
Coupling Control Port	Select any port of this switch to be the coupling control port	Port 7

Configuring "Turbo Ring V2"

The following figure indicates which Turbo Ring V2 parameters can be configured. A more detailed explanation of each parameter follows.



NOTE When using the Dual-Ring architecture, you must configure settings for both Ring 1 and Ring 2. In this case, the status of both rings will appear under "Status."

Explanation of "Status" Items

Active Protocol

Shows which redundancy protocol is in use: **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, **MSTP** or **None**.

Ring 1/2: Role

Indicates whether or not this switch is the **Master** or **Slave** of the Turbo Ring. (When using the Dual-Ring architecture and this switch is selected to operate on both rings, you must configure settings for both Ring 1 and Ring 2 at this switch. In this case, the status of both rings will appear under "Status.")

NOTE The user does not need to set the master to use Turbo Ring. If master is not set, the Turbo Ring protocol will assign master status to one of the switches in the ring. The master is only used to determine which segment serves as the backup path.

Ring 1/2: Turbo Ring Status

Shows **Healthy** if the ring is operating normally, and shows **Break** if the ring's backup link is active.

Ring 1/2: 1st Port Status / Ring 1/2: 2nd Port Status

The "Ports Status" indicators show ***Forwarding*** for normal transmission, ***Blocking*** if this port is connected to a backup path and the path is blocked, and ***Link down*** if there is no connection.

Ring Coupling: Role

Indicates **None**, **Dual Homing**, or **Ring Coupling**.

Ring Coupling: Primary Port

The "Primary Port" indicators show ***Forwarding*** for normal transmission, and ***Link down*** if there is no connection.

Ring Coupling: Backup Port Status

The "Backup Port Status" indicators show ***Forwarding***, ***Blocking***, or ***Link down.***

Explanation of "Settings" Items

Ring 1

Setting	Description	Factory Default
Enabled	Enable the Ring 1 settings	checked
Disabled	Disable the Ring 1 settings	

Ring 2*

Setting	Description	Factory Default
Enabled	Enable the Ring 2 settings	Not checked
Disabled	Disable the Ring 2 settings	

NOTE You should enable both Ring 1 and Ring 2 when the switch interconnects between Ring 1 and Ring 2 in the Dual-Ring architecture.

Set as Master (Ring 1/2)

Setting	Description	Factory Default
Enabled	Select this switch as Master	Not checked
Disabled	Do not select this switch as Master	

Redundant Ports (Ring 1/2)

Setting	Description	Factory Default
1st Port	Select any port of this switch to be one of the redundant ports.	Ring 1: G2 Ring 2: G1
2nd Port	Select any port of this switch to be one of the redundant ports.	Ring 1: G3 Ring 2: 7

Ring Coupling: Enable

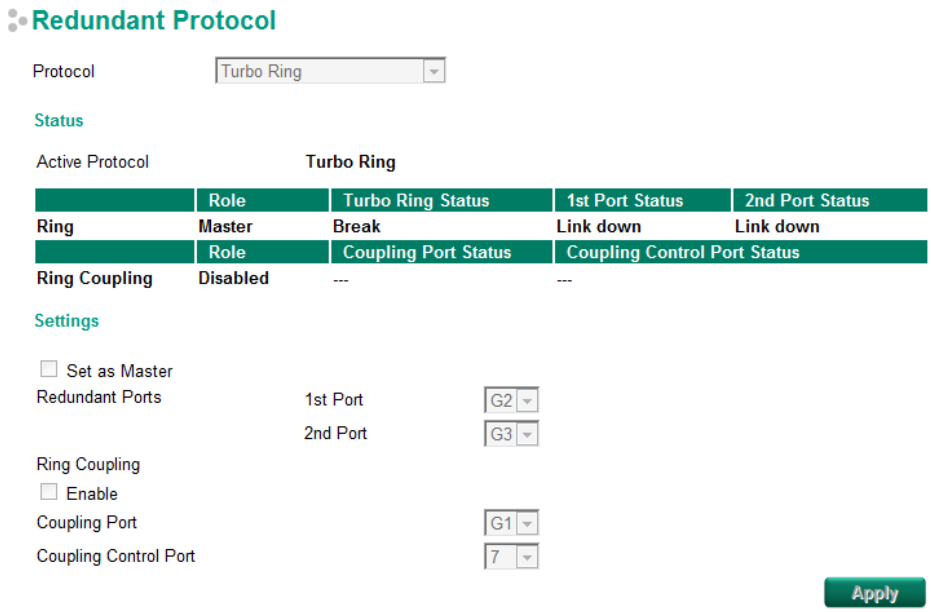
Setting	Description	Factory Default
Enable	Select this switch as Coupler	Not checked
Disable	Do not select this switch as Coupler	

Ring Coupling: Coupling Mode

Setting	Description	Factory Default
Dual Homing	Select this item to change to the Dual Homing configuration page	Primary port: 1 Backup port: 2
Ring Coupling (backup)	Select this item to change to the Ring Coupling (backup) configuration page	Port 1
Ring Coupling (primary)	Select this item to change to the Ring Coupling (primary) configuration page	Port 1

NOTE The Turbo Ring DIP Switches located on the outer casing of the EDS E series switches can be used to configure switch Turbo Ring protocols (Turbo Ring or Turbo Ring V2).

If the **Turbo Ring DIP Switch** is enabled from any access interface (web-based UI, console, or Telnet), and the 4th DIP Switch on the switch outer casing is set to **ON**, the Redundancy Protocol will be set automatically to the Turbo Ring protocol based on the version configured in the **Turbo Ring DIP Switch** page, and the corresponding Redundant Ports, Coupling Ports, and Coupling Control Port will be fixed to the assigned factory default port number automatically. In this case, you will not be able to use the web-based UI, console, or Telnet interface to change the status of the DIP Switch and all settings in the Redundancy Protocol page will not be allowed to be configured, as shown in the following figure:



In addition, those default Redundant Ports, Coupling Ports, and Coupling Control Port will be added automatically to all VLANs (i.e., to act as "Trunk Ports") if you set the 4th DIP Switch to the "ON" position when the Turbo Ring DIP Switch is enabled. Once you flip the 4th DIP Switch back from **ON** to **OFF** when the Turbo Ring DIP Switch is enabled, such default Redundant Ports, Coupling Ports, and Coupling Control Port that were added to all VLANs will be restored to their previous software settings.

3

Turbo Chain

The following topics are covered in this chapter:

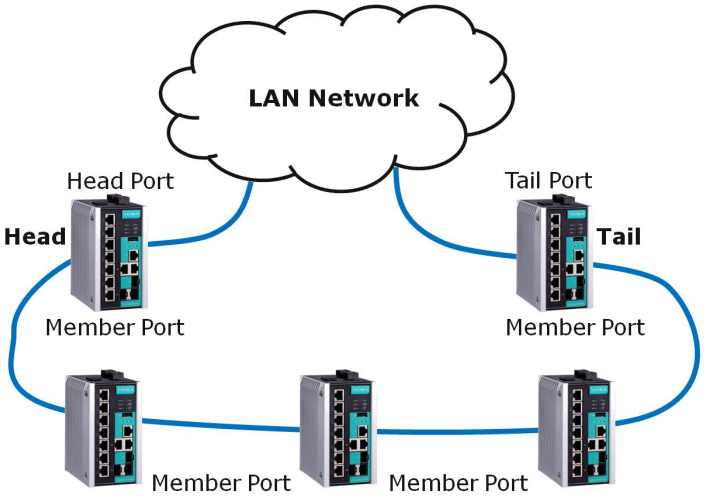
- **The Turbo Chain Concept**
- **Setting Up Turbo Chain**
- **Configuring "Turbo Chain"**
  - Head Switch Configuration
  - Member Switch Configuration
  - Tail Switch Configuration

The Turbo Chain Concept

Moxa's Turbo Chain is an advanced software technology that gives network administrators the flexibility of constructing any type of redundant network topology. When using the "chain" concept, you first connect the Ethernet switches in a chain and then simply link the two ends of the chain to an Ethernet network, as illustrated in the following figure.

Turbo Chain can be used on industrial networks that have a complex topology. If the industrial network uses a multi-ring architecture, Turbo Chain can be used to create flexible and scalable topologies with a fast media-recovery time.

Setting Up Turbo Chain



1. Select the Head switch, Tail switch, and Member switches.
2. Configure one port as the Head port and one port as the Member port in the Head switch, configure one port as the Tail port and one port as the Member port in the Tail switch, and configure two ports as Member ports in each of the Member switches.
3. Connect the Head switch, Tail switch, and Member switches as shown in the above diagram.

The path connecting to the Head port is the main path, and the path connecting to the Tail port is the backup path of the Turbo Chain. Under normal conditions, packets are transmitted through the Head Port to the LAN network. If any Turbo Chain path is disconnected, the Tail Port will be activated so that packet transmission can continue.

Configuring "Turbo Chain"

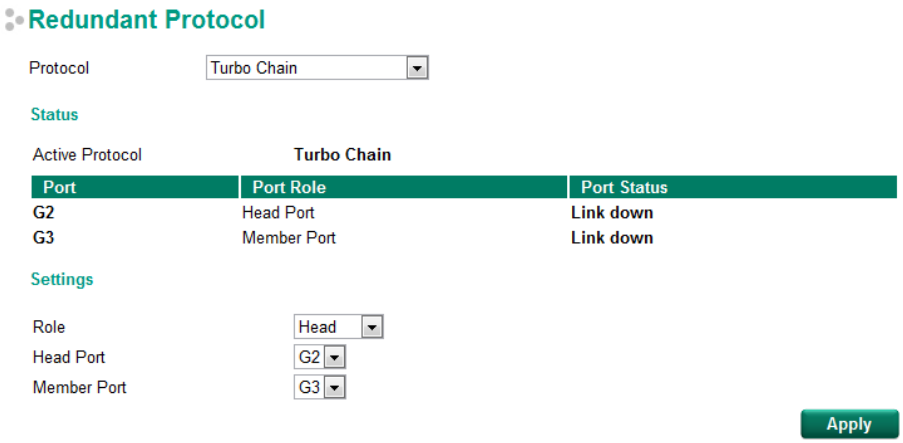
Use the scrollbar at the top of the Redundancy Protocol page to select **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, or **MSTP**. Note that the configuration pages for these five protocols are different.

Protocol

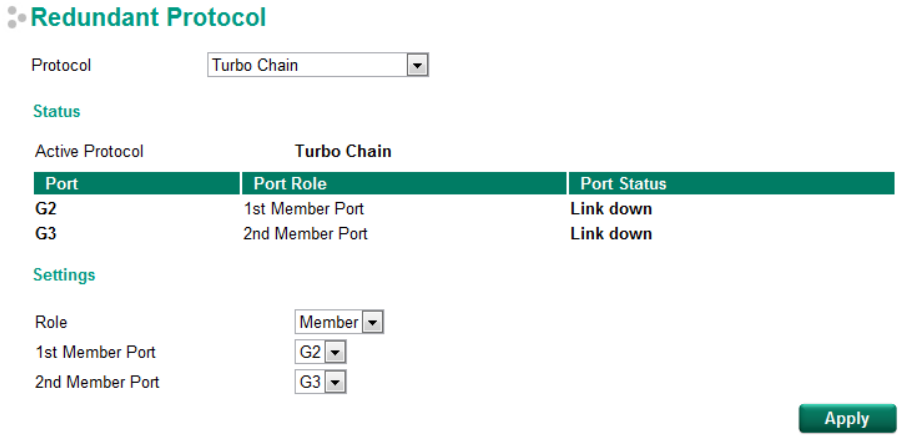
Setting	Description	Factory Default
Turbo Ring	Select this item to change to the Turbo Ring configuration page.	None
Turbo Ring V2	Select this item to change to the Turbo Ring V2 configuration page.	
Turbo Chain	Select this item to change to the Turbo Chain configuration page.	
RSTP (IEEE 802.1D-2004)	Select this item to change to the RSTP configuration page.	
MSTP (IEEE 802.1s)	Select this item to change to the MSTP configuration page.	

The following figures indicate which Turbo Chain parameters can be configured. A more detailed explanation of each parameter follows.

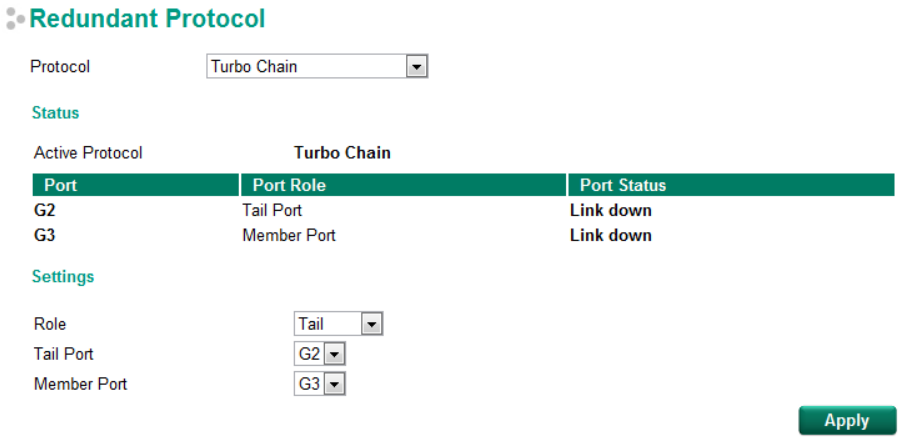
Head Switch Configuration



Member Switch Configuration



Tail Switch Configuration



Explanation of "Status" Items

Active Protocol

Shows which redundancy protocol is in use: **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, **MSTP** or **None.**

Port

Shows which ports have been assigned for redundancy protocol usage.

Port Role

Shows the role that has been assigned to any specific redundancy port: Head, Member, or Tail.

Port Status

The "Ports Status" indicators show ***Forwarding*** for normal transmission, ***Blocked*** if this port is connected to the Tail port as a backup path and the path is blocked, and ***Link down*** if there is no connection.

Explanation of "Settings" Items

Role

Setting	Description	Factory Default
Head	Select this switch as Head Switch	Member
Member	Select this switch as Member Switch	
Tail	Select this switch as Tail Switch	

Head Role

Setting	Description	Factory Default
Head Port	Select any port of this switch to be the head port.	G2
Member Port	Select any port of this switch to be the member port.	G3

Member Role

Setting	Description	Factory Default
1st Member port	Select any port of this switch to be the 1st member port	G2
2nd Member port	Select any port of this switch to be the 2nd member port	G3

Tail Role

Setting	Description	Factory Default
Tail Port	Select any port of this siwtch to be the tail port.	G2
Member Port	Select any port of this switch to be the member port.	G3

4

STP/RSTP/MSTP

The following topics are covered in this chapter:

- **The STP/RSTP/MSTP Concept**
  - What is STP?
  - How STP Works
  - Differences between STP, RSTP, and MSTP
- **STP Example**
- **Using STP on a Network with Multiple VLANs**
- **Configuring STP/RSTP**
- **Configuring MSTP**
- **Configuration Limits of STP/RSTP**

The STP/RSTP/MSTP Concept

Spanning Tree Protocol (STP) was designed to help reduce link failures on a network, and provide an automatic means of avoiding loops. This is particularly important for networks that have a complicated architecture, since unintended loops in the network can cause broadcast storms. Moxa switches' STP feature is disabled by default. To be completely effective, you must enable RSTP/STP on every Moxa switch connected to your network.

Rapid Spanning Tree Protocol (RSTP) implements the Spanning Tree Algorithm and Protocol defined by IEEE 802.1D-2004. RSTP provides the following benefits:

- The topology of a bridged network will be determined much more quickly compared to STP.
- RSTP is backwards compatible with STP, making it relatively easy to deploy. For example:
  - Defaults to sending 802.1D style BPDUs if packets with this format are received.
  - STP (802.1D) and RSTP (802.1w) can operate on different ports of the same switch, which is particularly helpful when switch ports connect to older equipment such as legacy switches.

You get essentially the same functionality with RSTP and STP. To see how the two systems differ, see the ***Differences between STP, RSTP, and MSTP*** section in this chapter.

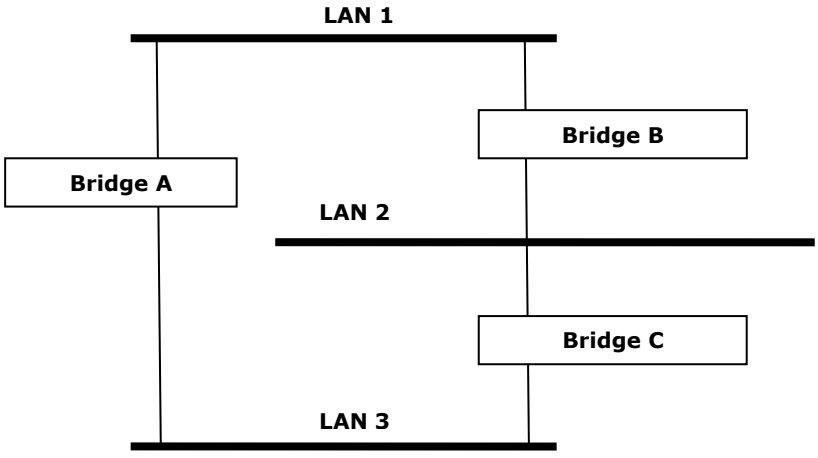
NOTE The STP protocol is part of the IEEE Std 802.1D, 2004 Edition bridge specification. The following explanation uses "bridge" instead of "switch."

What is STP?

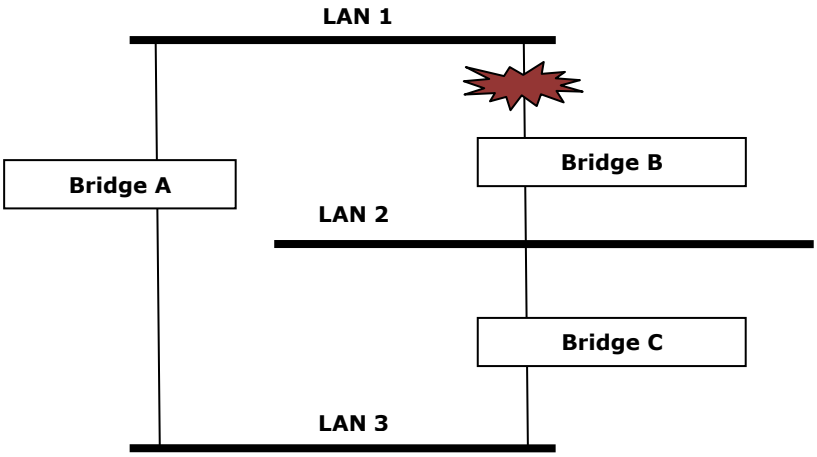
STP (802.1D) is a bridge-based system that is used to implement parallel paths for network traffic. STP uses a loop-detection process to:

- Locate and then disable less efficient paths (i.e., paths that have a lower bandwidth).
- Enable one of the less efficient paths if a more efficient path fails.

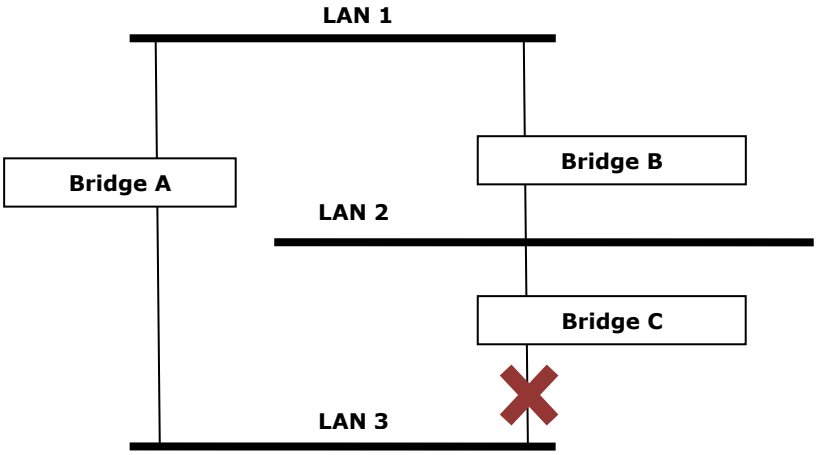
The figure below shows a network made up of three LANs separated by three bridges. Each segment uses at most two paths to communicate with the other segments. Since this configuration can give rise to loops, the network will overload if STP is NOT enabled.



If STP is enabled, it will detect duplicate paths and prevent, or *block*, one of the paths from forwarding traffic. In the following example, STP determined that traffic from LAN segment 2 to LAN segment 1 should flow through bridges C and A since this path has a greater bandwidth and is therefore more efficient.



What happens if a link failure is detected? As shown in next figure, the STP process reconfigures the network so that traffic from LAN segment 2 flows through bridge B.



STP will determine which path between each bridged segment is most efficient, and then assign a specific reference point on the network. When the most efficient path has been identified, the other paths are blocked. In the previous 3 figures, STP first determined that the path through bridge C was the most efficient, and as a result, blocked the path through bridge B. After the failure of bridge C, STP re-evaluated the situation and opened the path through Bridge B.

How STP Works

When enabled, STP determines the most appropriate path for traffic through a network. The way it does this is outlined in the sections below.

STP Requirements

Before STP can configure the network, the system must satisfy the following requirements:

- All bridges must be able to communicate with each other. The communication is carried out using Bridge Protocol Data Units (BPDUs), which are transmitted in packets with a known multicast address.
- Each bridge must have a Bridge Identifier that specifies which bridge acts as the central reference point, or Root Bridge, for the STP system—bridges with a lower Bridge Identifier are more likely to be designated as the Root Bridge. The Bridge Identifier is calculated using the MAC address of the bridge and a priority defined for the bridge. For example, the default priority setting of Moxa switches is 32768.
- Each port has a cost that specifies the efficiency of each link. The efficiency cost is usually determined by the bandwidth of the link, with less efficient links assigned a higher cost.

STP Calculation

The first step of the STP process is to perform calculations. During this stage, each bridge on the network transmits BPDUs. The following items will be calculated:

- Which bridge should be the **Root Bridge**. The Root Bridge is the central reference point from which the network is configured.
- The **Root Path Costs** for each bridge. This is the cost of the paths from each bridge to the Root Bridge.
- The identity of each bridge's **Root Port**. The Root Port is the port on the bridge that connects to the Root Bridge via the most efficient path. In other words, the port connected to the Root Bridge via the path with the lowest Root Path Cost. The Root Bridge, however, does not have a Root Port.
- The identity of the **Designated Bridge** for each LAN segment. The Designated Bridge is the bridge with the lowest Root Path Cost from that segment. If several bridges have the same Root Path Cost, the one with the lowest Bridge Identifier becomes the Designated Bridge. Traffic transmitted in the direction of the Root Bridge will flow through the Designated Bridge. The port on this bridge that connects to the segment is called the **Designated Bridge Port**.

STP Configuration

After all of the bridges on the network agree on the identity of the Root Bridge, and all other relevant parameters have been established, each bridge is configured to forward traffic only between its Root Port and the Designated Bridge Ports for the respective network segments. All other ports are blocked, which means that they will not be allowed to receive or forward traffic.

STP Reconfiguration

Once the network topology has stabilized, each bridge listens for Hello BPDUs transmitted from the Root Bridge at regular intervals. If a bridge does not receive a Hello BPDU after a certain interval (the Max Age time), the bridge assumes that the Root Bridge, or a link between itself and the Root Bridge, has ceased to funtion. This will trigger the bridge to reconfigure the network to account for the change. If you have configured an SNMP trap destination, the first bridge to detect the change will send out an SNMP trap when the topology of your network changes.

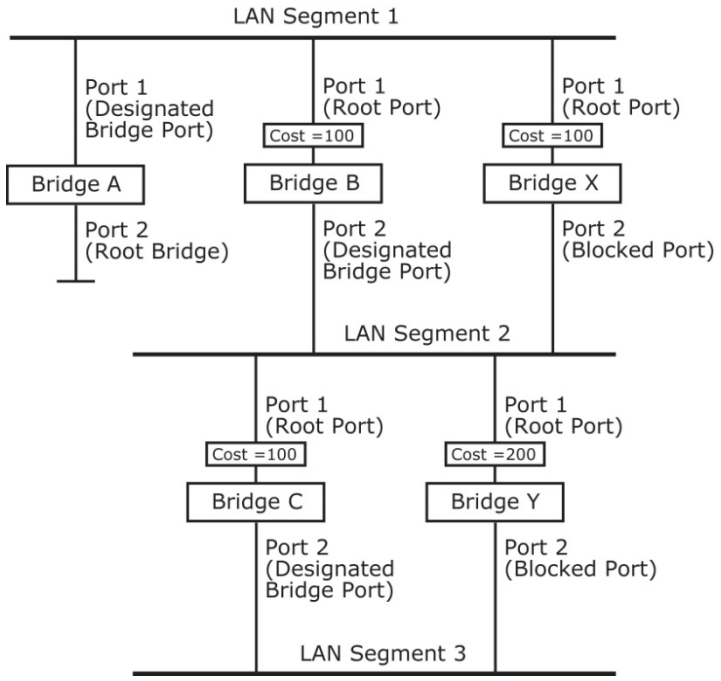
Differences between STP, RSTP, and MSTP

RSTP is similar to STP, but includes additional information in the BPDUs that allow each bridge to confirm that it has taken action to prevent loops from forming when it decides to enable a link to a neighboring bridge. Adjacent bridges connected via point-to-point links will be able to enable a link without waiting to ensure that all other bridges in the network have had time to react to the change. The main benefit of RSTP is that the configuration decision is made locally rather than network-wide, allowing RSTP to carry out automatic configuration and restore a link faster than STP.

STP and RSTP spanning tree protocols operate without regard to a network's VLAN configuration, and maintain one common spanning tree throughout a bridged network. Thus, these protocols map one loop-free, logical topology on a given physical topology. MSTP uses VLANs to create multiple spanning trees in a network, which significantly improves network resource utilization while maintaining a loop-free environment.

STP Example

The LAN shown in the following figure has three segments, with adjacent segments connected using two possible links. The various STP factors, such as Cost, Root Port, Designated Bridge Port, and Blocked Port are shown in the figure.

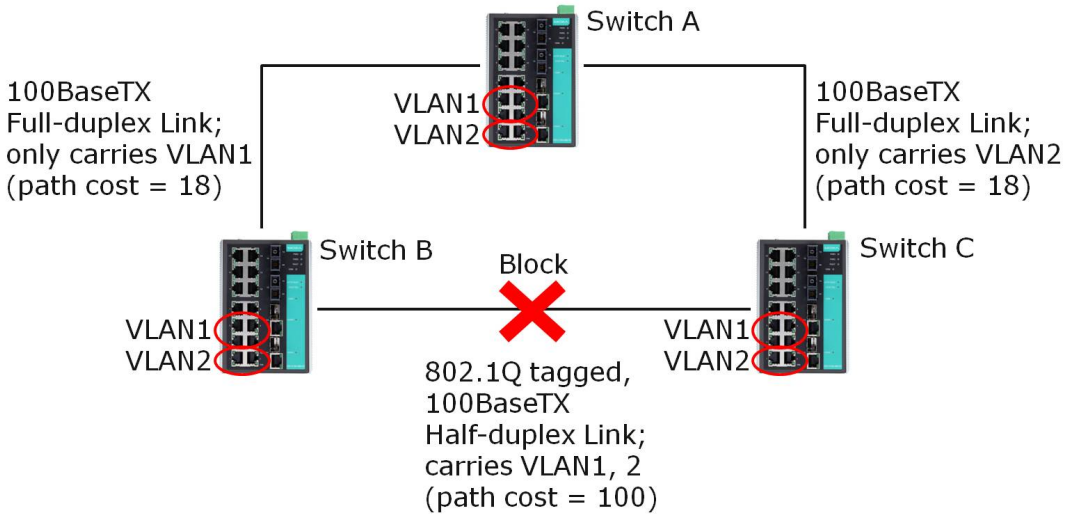


- Bridge A has been selected as the Root Bridge, since it was determined to have the lowest Bridge Identifier on the network.
- Since Bridge A is the Root Bridge, it is also the Designated Bridge for LAN segment 1. Port 1 on Bridge A is selected as the Designated Bridge Port for LAN Segment 1.
- Ports 1 of Bridges B, C, X, and Y are all Root Ports since they are nearest to the Root Bridge, and therefore have the most efficient path.
- Bridges B and X offer the same Root Path Cost for LAN segment 2. However, Bridge B was selected as the Designated Bridge for that segment since it has a lower Bridge Identifier. Port 2 on Bridge B is selected as the Designated Bridge Port for LAN Segment 2.
- Bridge C is the Designated Bridge for LAN segment 3, because it has the lowest Root Path Cost for LAN Segment 3:
  - The route through bridges C and B costs 200 (C to B=100, B to A=100)
  - The route through bridges Y and B costs 300 (Y to B=200, B to A=100)
- The Designated Bridge Port for LAN Segment 3 is port 2 on bridge C.

Using STP on a Network with Multiple VLANs

IEEE Std 802.1D, 1998 Edition, does not take into account VLANs when calculating STP information—the calculations only depend on the physical connections. Consequently, some network configurations will result in VLANs being subdivided into a number of isolated sections by the STP system. You must ensure that every VLAN configuration on your network takes into account the expected STP topology and alternative topologies that may result from link failures.

The following figure shows an example of a network that contains VLANs 1 and 2. The VLANs are connected using the 802.1Q-tagged link between switch B and Switch C. By default, this link has a port cost of 100 and is automatically blocked because the other switch-to-switch connections have a port cost of 36 (18+18). This means that both VLANs are now subdivided—VLAN 1 on switches A and B cannot communicate with VLAN 1 on switch C, and VLAN 2 on switches A and C cannot communicate with VLAN 2 on switch B.



To avoid subdividing VLANs, all inter-switch connections should be made members of all available 802.1Q VLANs. This will ensure connectivity at all times. For example, the connections between switches A and B, and between switches A and C, should be 802.1Q tagged and carrying VLANs 1 and 2 to ensure connectivity.

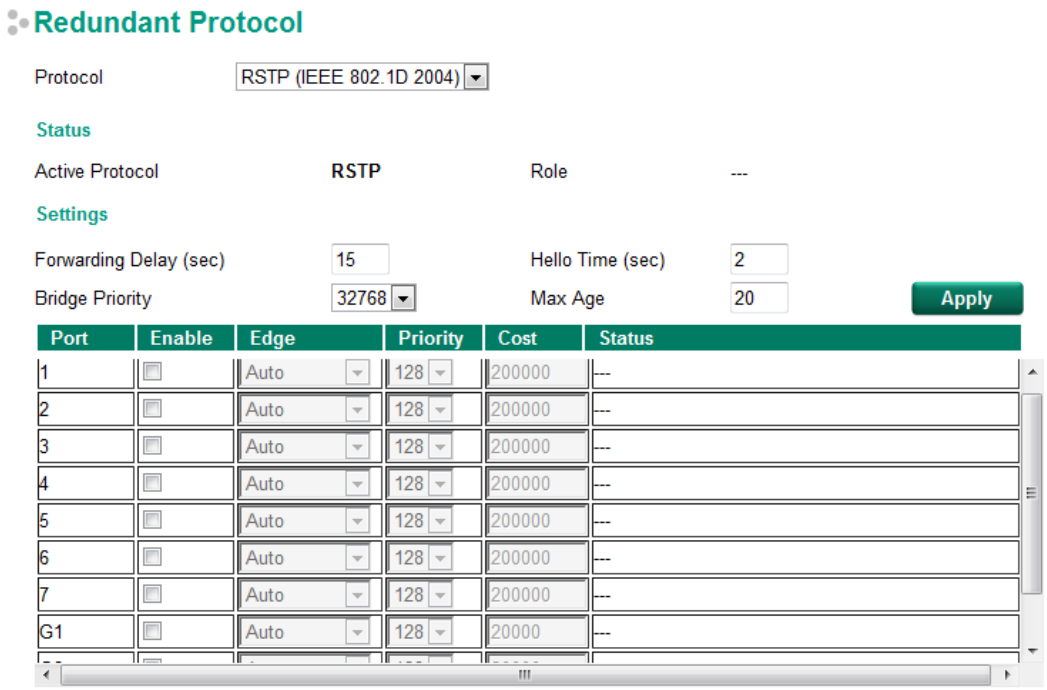
Configuring STP/RSTP

Use the scrolling bar at the top of the Redundancy Protocol page to select among **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, or **MSTP**. Note that configuration pages for these five protocols are different.

Protocol

Setting	Description	Factory Default
Turbo Ring	Select this item to change to the Turbo Ring configuration page.	None
Turbo Ring V2	Select this item to change to the Turbo Ring V2 configuration page.	
Turbo Chain	Select this item to change to the Turbo Chain configuration page.	
RSTP (IEEE 802.1D-2004)	Select this item to change to the RSTP configuration page.	
MSTP (IEEE 802.1s)	Select this item to change to the MSTP configuration page.	

The following figure indicates which Spanning Tree Protocol parameters can be configured. A more detailed explanation of each parameter follows.



Explanation of "Status" Items

Active Protocol

Shows which redundancy protocol is in use: **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, **MSTP**, or **None.**

Role

This field only appears when RSTP mode is selected. The field indicates whether or not this switch is the ***Root*** of the Spanning Tree (the root is determined automatically).

Explanation of "Settings" Items

Forwarding delay (sec.)

Setting	Description	Factory Default
Numerical value input by user	The amount of time this device waits before checking to see if it should change to a different state.	15

Bridge priority

Setting	Description	Factory Default
Numerical value selected by user	Increase this device's bridge priority by selecting a lower number. A device with a higher bridge priority has a greater chance of being established as the root of the Spanning Tree topology.	32768

Hello time (sec.)

Setting	Description	Factory Default
Numerical value input by user	The root of the Spanning Tree topology periodically sends out a "hello" message to other devices on the network to check if the topology is healthy. The "hello time" is the amount of time the root waits between sending hello messages.	2

Max. Age (sec.)

Setting	Description	Factory Default
Numerical value input by user	If this device is not the root, and it has not received a hello message from the root in an amount of time equal to "Max. Age," then this device will reconfigure itself as a root. Once two or more devices on the network are recognized as a root, the devices will renegotiate a new Spanning Tree topology.	20

Enable STP per Port

Setting	Description	Factory Default
Enable/Disable	Select to enable the port as a node on the Spanning Tree topology.	Disabled

NOTE We suggest not enabling the Spanning Tree Protocol once the port is connected to a device (PLC, RTU, etc.) as opposed to network equipment. The reason is that it will cause unnecessary negotiation.

Edge

Setting	Description	Factory Default
Auto	1. If the port does not receive a BPDU within 3 seconds, the port will be in the forwarding state. 2. Once the port receives a BPDU, it will start the RSTP negotiation process.	Auto
Force Edge	The port is fixed as an edge port and will always be in the forwarding state	
False	The port is set as the normal RSTP port	

Priority

Setting	Description	Factory Default
Numerical value selected by user	Increase this port's priority as a node on the Spanning Tree topology by entering a lower number.	128

Cost

Setting	Description	Factory Default
Numerical value input by user	Input a higher cost to indicate that this port is less suitable as a node for the Spanning Tree topology.	200000

Status

Indicates the current Spanning Tree status of this port. **Forwarding** for normal transmission, **Blocking** for block transmission, or **Link down** for no connection.

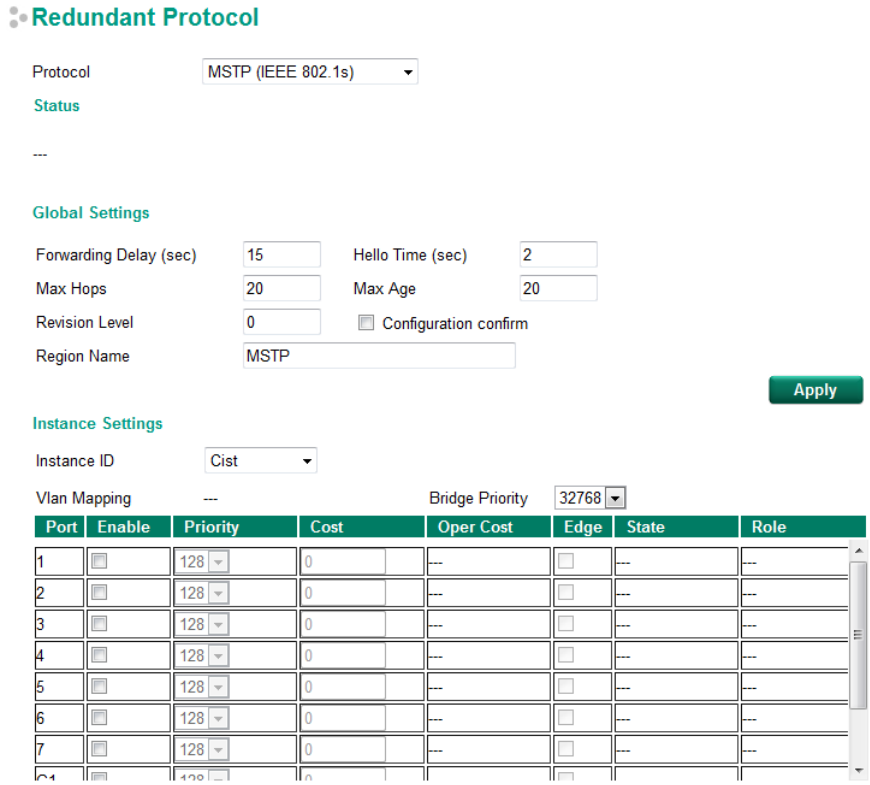
Configuring MSTP

Use the scrollbar at the top of the Redundancy Protocol page to select **Turbo Ring**, **Turbo Ring V2**, **Turbo Chain**, **RSTP**, or **MSTP**. Note that configuration pages for these five protocols are different.

Protocol

Setting	Description	Factory Default
Turbo Ring	Select this item to change to the Turbo Ring configuration page.	None
Turbo Ring V2	Select this item to change to the Turbo Ring V2 configuration page.	
Turbo Chain	Select this item to change to the Turbo Chain configuration page.	
RSTP (IEEE 802.1D-2004)	Select this item to change to the RSTP configuration page.	
MSTP (IEEE 802.1s)	Select this item to change to the MSTP configuration page.	

The following figure indicates which Multiple Spanning Tree Protocol parameters can be configured. A more detailed explanation of each parameter follows.



Explanation of "Status" Items

Status

Indicates the Root bridge of the Spanning Tree.

Explanation of "Global Settings" Items

Forwarding Delay (sec.)

Setting	Description	Factory Default
Numerical value input by user (4-30)	The amount of time this device waits before checking to see if it should change to a different state.	15

Hello time (sec.)

Setting	Description	Factory Default
Numerical value input by user (1-10)	The root of the Spanning Tree topology periodically sends out a "hello" message to other devices on the network to check if the topology is healthy. The "hello time" is the amount of time the root waits between sending hello messages.	2

Max Hops

Setting	Description	Factory Default
Numerical value input by user (6-40)	The MSTP maximum hops value is the maximum number of hops in the region. Configure the maximum number of hops a BPDU can be forwarded in the MSTP region.	20

Max. Age (sec.)

Setting	Description	Factory Default
Numerical value input by user (6-40)	If this device is not the root, and it has not received a hello message from the root in an amount of time equal to "Max. Age," then this device will reconfigure itself as a root. Once two or more devices on the network are recognized as a root, the devices will renegotiate to set up a new Spanning Tree topology.	20

Revision Level

Setting	Description	Factory Default
Numerical value input by user (0-65535)	The MSTP revision level is the revision number of the configuration. All EDS switches in an MSTP region must be configured with the same revision level.	0

Region Name

Setting	Description	Factory Default
Character string	The region name helps define the logical boundary of the network. All EDS switches in an MSTP region must be configured with the same name.	MSTP

Configuration confirm

Setting	Description	Factory Default
Enable/Disable	Clicking "Apply" button will only save the MSTP settings temporarily; you can select to enable this configuration to activate the MSTP settings during the operation.	Disabled

Explanation of "Instance Settings" Items

Instance ID

Setting	Description	Factory Default
Numerical value selected by user	Within each MST region, the MSTP maintains multiple spanning-tree instances. A common and internal spanning tree (CIST) is a collection of the following: ISTs in each MST region, and the common spanning tree (CST) that interconnects the MST regions, and a single spanning tree. All other MST instances are numbered from 1 to 15.	Cist

Vlan Mapping

Setting	Description	Factory Default
Numerical value input by user (1-4094)	Configure which VLAN ID is mapped to the multiple spanning-tree instances.	None

Bridge priority

Setting	Description	Factory Default
Numerical value selected by user	Increase this device's bridge priority by selecting a lower number. A device with a higher bridge priority has a greater chance of being established as the root of the Spanning Tree topology.	32768

Enable

Setting	Description	Factory Default
Enable/Disable	Select to enable the port as a node on the Multiple Spanning Tree topology.	Disabled

Priority

Setting	Description	Factory Default
Numerical value selected by user	Increase this port's priority as a node on the Multiple Spanning Tree topology by entering a lower number.	128

Cost

Setting	Description	Factory Default
Numerical value input by user	Input a higher cost to indicate that this port is less suitable as a node for the Multiple Spanning Tree topology. Use the default value (0) to use port speed in the auto port cost.	0

Oper Cost

It indicates the cost of the path to the other bridge from this transmitting bridge at the specified port.

Edge

Setting	Description	Factory Default
Enable/Disable	Select to enable the port as the edge port for the Multiple Spanning Tree topology.	Disabled

State

Indicates the current Multiple Spanning Tree status of this port. The "Blocking" status indicates the transmission is blocked; the "Learning" status indicates the MAC address of the device is being recorded in the MAC table, and the "Forwarding" status indicates normal transmission.

Role

Indicates the current port role status.

Setting	Port Role Status	Factory Default
Port Role	Backup Alternate port Root port Designated port Disable	None

Configuration Limits of STP/RSTP

The Spanning Tree Algorithm places limits on three of the configuration items described previously:

[Eq. 1]: 1 sec $\leqq$ Hello Time $\leqq$ 10 sec
[Eq. 2]: 6 sec $\leqq$ Max. Age $\leqq$ 40 sec
[Eq. 3]: 4 sec $\leqq$ Forwarding Delay $\leqq$ 30 sec

These three variables are further restricted by the following two inequalities:

[Eq. 4]: 2 x (Hello Time + 1 sec) $\leqq$ Max. Age $\leqq$ 2 x (Forwarding Delay – 1 sec)

Moxa EDS-600's firmware will alert you immediately if any of these restrictions are violated. For example, setting

Hello Time = 5 sec, Max. Age = 20 sec, and Forwarding Delay = 4 sec does not violate Eqs. 1 through 3, but does violate Eq. 4, since in this case,

2 x (Hello Time + 1 sec) = 12 sec, and 2 x (Forwarding Delay – 1 sec) = 6 sec.

You can remedy the situation in many ways. One solution is simply to increase the Forwarding Delay value to at least 11 sec.

HINT: Perform the following steps to avoid guessing:

Step 1: Assign a value to **Hello Time** and then calculate the left most part of Eq. 4 to get the lower limit of **Max. Age**.

Step 2: Assign a value to **Forwarding Delay** and then calculate the right most part of Eq. 4 to get the upper limit for **Max. Age**.

Step 3: Assign a value to **Forwarding Delay** that satisfies the conditions